The low prevalence of *T. gondii* in bighorn sheep may be due to their habitat: they usually live in remote, mountainous regions of western North America. *Toxoplasma gondii* infection in humans and other animals is generally lower in the mountains than in the plains (Dubey and Beattie, 1988). The low prevalence of *T. gondii* antibodies in bighorn sheep is markedly different from a high prevalence of *T. gondii* in domestic sheep. With the same MAT test used in the present study, antibodies (≥1:64) to *T. gondii* were found in 65.5% of 1,564 sheep from 33 farms in the midwestern United States (Dubey and Kirkbride, 1989). The importance of *T. gondii* in bighorn sheep is unknown but should be considered in areas where the reproductive rate is less than anticipated.

The seroprevalence of *T. gondii* in bighorn sheep in the present study is markedly lower than 22% (178 of 719) seroprevalance in bighorn sheep from California reported by Clark et al. (1993) and Elliot et al. (1994); both studies used the same data. However, these authors did not mention the antibody titers found nor the serologic test used to detect *T. gondii* antibodies. Therefore, we cannot compare their results to the present study.

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Prevalence of Antibodies to *Toxoplasma gondii* in Ostriches (*Struthio camelus*)

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ABSTRACT: Serum samples from 973 ostriches (*Struthio camelus*) in Canada were examined for antibodies to *Toxoplasma gondii* by the modified agglutination test incorporating mercaptoethanol and formalin-fixed whole tachyzoites. Twenty-eight (2.9%) of the 973 birds were found to be seropositive for antibodies to *T. gondii* at titers of 1:25 in 15 birds, 1:50 in 12 birds, and 1:500 in 1 bird. This is the first record of *T. gondii* exposure in ostriches, and it supports the hypothesis that all avian species are susceptible to *Toxoplasma* infection. Nevertheless, the results of this study suggest that the risk of acquiring toxoplasmosis from ostriches as a food source is low.

Toxoplasma gondii is known to infect many species of warm-blooded animals including birds (Dubey and Beattie, 1988; Dubey, Camargo et al., 1993; Dubey, Ruff et al., 1993a, 1993b; Dubey et al., 1994; Dubey, Goodwin et al., 1995). Ostriches (*Struthio camelus*) are large birds that have been imported into many developed countries where they are raised on game farms as nontraditional livestock. In North America, the ostrich population consists of birds that have been acquired live or as fertilized eggs from overseas sources and from locally established breeding flocks. Meat from ostriches is considered highly palatable and low in fats. Because little is known of *T. gondii* infection in wild or game-farmed ratites, we conducted the present survey for the prevalence of specific antibodies as an indication of *T. gondii* infection.

Blood samples were obtained from 973 captive-ranched ostriches in 6 Canadian provinces representing central (Quebec–36, Ontario–138) and western (Manitoba–47, Saskatchewan–48, Alberta–661, British Columbia–43) regions of the country. Birds were sampled between 4 July and 13 September 1995 and between 11 June and 15 October 1997. Overall, the serum samples represented both sexes, and age of the birds ranged from young to mature adults. Samples were originally collected by routine venipuncture of jugular, brachial, or medial metatarsal veins to accommodate testing for health certification of the birds for international export. Following these required tests, the remaining serum samples were stored at −20 C and subsequently utilized in this current study.

The samples were shipped frozen to the U.S. Department of Agriculture's Parasite Biology and Epidemiology Laboratory, Beltsville, Maryland for serologic testing. Sera were diluted 1: 25, 1:50, and 1:500 with phosphate-buffered saline and examined for *T. gondii* antibodies using the modified agglutination test (MAT) as previously described (Dubey and Desmonts, 1987). Formalin-fixed tachyzoites were used in the MAT.

Twenty-eight of 973 (2.9%) birds were seropositive for antibodies to *T. gondii* at titers of 1:25 in 15 birds, 1:50 in 12 birds, and 1:500 in 1 bird. A MAT titer of 1:25 is considered indicative of *T. gondii* infection based on statistically validated studies in pigs (Dubey, Thulliez et al., 1995; Dubey, 1997). There have been no other validation studies on serologic tests for *T. gondii* infection in animals. The MAT has been accepted as a reliable assay for *Toxoplasma* infection in several animal species including many avian species (Dubey, Camargo et al., 1993; Dubey, Ruff et al.,

1993a, 1993b; Dubey et al., 1994; Dubey, Goodwin et al., 1995), and it is reasonable to believe that the results of this study are accurate. Orosz et al. (1992) reported MAT titers of 1:4,096 in an adult male cassowary (*Casuarius casuarius*) and in an 8-mo-old rhea (*Rhea americana*) suspected to have clinical toxoplasmosis. Two other cassowaries and 3 ostriches on the same farm tested negative for MAT *T. gondii* antibodies. The rheas look similar to ostriches but are smaller than ostriches.

To our knowledge, this is the first record of *T. gondii* infection in ostriches. Although the parasite has been found in various species of birds and in eggs, toxoplasmosis is not recognized as an animal health problem in any species of farmed birds. Similarly, the consumption of avian meat or eggs has not been considered as a likely source of infection for *T. gondii* in people (Dubey and Beattie, 1988). The results of this study demonstrate a low prevalence of *T. gondii* infection in farmed ostriches and suggest that consumers are unlikely to acquire toxoplasmosis from ostrich meat. Testing of meat for the actual presence of *T. gondii* can be accomplished by the use of bioassays or DNA probes (Dubey and Beattie, 1988; MacPherson and Gajadhar, 1993).

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Experimental Transmission of *Sarcocystis speeri* Dubey and Lindsay, 1999 from the South American Opossum (*Didelphis albiventris*) to the North American Opossum (*Didelphis virginiana*)

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ABSTRACT: *Sarcocystis speeri* Dubey and Lindsay, 1999 from the South American opossum *Didelphis albiventris* was successfully transmitted to the North American opossum *Didelphis virginiana.* Sporocysts from a naturally infected *D. albiventris* from Argentina were fed to 2 γ-interferon knockout (KO) mice. The mice were killed 64 and 71 days after sporocyst feeding (DAF). Muscles containing sarcocysts from the KO mouse killed 71 DAF were fed to a captive *D. virginiana*; this opossum shed sporocysts 11 days after ingesting sarcocysts. Sporocysts from *D. virginiana* were fed to 9 KO mice and 4 budgerigars (*Melopsittacus undulatus*). Schizonts, sarcocysts, or both of *S. speeri* were found in tissues of all 7 KO mice killed 29–85 DAF; 2 mice died 39 and 48 DAF were not necropsied. *Sarcocystis* stages were not found in tissues of the 4 budgerigars fed *S. speeri* sporocysts and killed 35 DAF. These results indicate that *S. speeri* is distinct from *Sarcocystis falcatula* and *Sarcocystis neurona,* and that *S. speeri* is present in both *D. albiventris* and *D. virginiana.*

The North American opossum is a host for at least 3 pathogenic species of *Sarcocystis*: *Sarcocystis falcatula* (Box and Duszynski, 1978; Duszynski and Box, 1978; Box et al., 1984; Marsh et al., 1997), *Sarcocystis neurona* (Dubey et al., 1991; Fenger et al., 1997; Dubey and Lindsay, 1998), and *Sarcocystis speeri* (Dubey et al., 1998; Dubey and Lindsay, 1999). Recently, *S. speeri*-like organisms were found in the South American opossum, *Didelphis albiventris* from Argentina (Dubey, Venturini et al., 2000). In the present paper, we present evidence that an *S. speeri*-like organism based on morphology from *D. albiventris* is transmissible and infective to *Didelphis virginiana.*

Gamma-interferon knockout (KO) mice (BALB/c-Ifng^{tm1Ts}) were obtained from Jackson Laboratories (Bar Harbor, Maine). The budgerigars (*Melopsittacus undulatus*) used were obtained from a local aviary. Two experiments were performed.

In experiment 1, sporocysts from opossum 1 (*D. albiventris*) from Argentina were fed to 2 KO mice (nos. 4217, 4218) and